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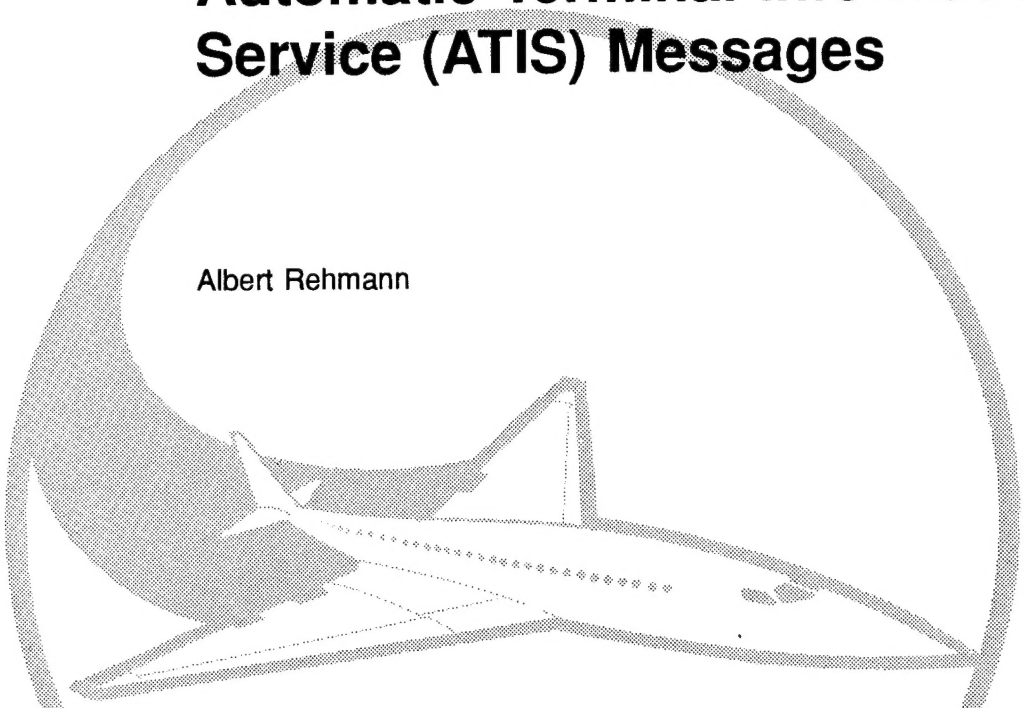
Evaluation of Synthetic Automatic Terminal Information Service (ATIS) Messages

Albert Rehmann



April 1995

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U.S. Department of Transportation
Federal Aviation Administration

Technical Center
Atlantic City Airport, NJ 08405

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16. Abstract

This report describes an evaluation of the effectiveness of synthetic voice Automatic Terminal Information Service (ATIS) messages in a simulated environment. The evaluation was conducted by ARINC and CTA, Incorporated, for the Federal Aviation Administration (FAA) Technical Center under contract DTFA03-94-Q-00022.

The evaluation consisted of a flight demonstration in the General Aviation Trainer (GAT) simulator at the FAA Technical Center, Atlantic City International Airport, NJ. The demonstration had the following objectives: (1) Evaluate synthetic voice messages using subjective measures of speed, clarity and intelligibility, and overall quality, and (2) Compare the pilots' responses to the synthetic voice messages with their responses to human voice messages.

These objectives were achieved by evaluating subjective and objective measures collected from the pilots and cockpit observers during the flight demonstration.

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EXECUTIVE SUMMARY

This effort was initiated to evaluate the effectiveness of a commercial product that generates speech from written text, in the presentation of Airport Terminal Information Service (ATIS) messages. The Federal Aviation Administration (FAA) plans to deploy workstations for airport tower operation that will generate relevant air traffic control messages, including ATIS, transmission via Data Link. However, for those aircraft not equipped with Data Link, such as general aviation, the voice broadcast of ATIS must be maintained. Text to speech, resident in the workstations, is envisioned as a means to provide this capability.

This evaluation was concentrated on general aviation operations and consisted of two flights from a point west of Woodstown, NJ, to an approach and landing at Atlantic City International Airport, NJ. Each flight was conducted in a simulator of a Cessna 421 twin aircraft, and airspace conditions included other traffic, light turbulence, and deteriorating weather. During the flight, ATIS was updated, and pilot subjects were required to listen to each message. Four conditions of flight scenarios and ATIS messages made up the flight experience. One flight scenario was routine, with background traffic equivalent to an average day in the Atlantic City area. The other flight scenario was designed to be higher workload, with more background radio traffic, and involved a runway change due to weather. An in-flight observer noted pilot awareness of any changes in the messages, as well as overall message content. Pilot subject commentary was also noted by the observer. Across all scenarios, natural speech ATIS was contrasted with the synthesized ATIS.

Data collection included subjective assessments by the pilot subjects via commentary and written questionnaires, and objective data such as the number of repetitions that pilot subjects listen to the ATIS.

Ten pilot subjects from the Atlantic Area participated in the study. Overall, their subjective ratings were favorable; indicated by a rating of 5.6 on a scale of 1 to 7. Moreover, no objective data suggested that there was any loss of ATIS information due to the synthetic speech compared to the natural speech case. Data did suggest that longer multisyllablic words, such as would be found in NOTAMS (Notices to Airmen) would be problematic, and cause additional workload for pilots. Shorter information bits such as altimeter settings and winds were not demonstrated to be a problem by the data.

This study showed that synthetic text to speech as implemented was rated favorable, but that further work is needed prior to field deployment. Due to the rigor of the experimental design used in this study, it can also form the basis for an evaluation of an improved text to speech system. Ratings used in this study can be applied in a future evaluation, and comparisons can be made.

1. OVERVIEW.

1.1 BACKGROUND AND OBJECTIVES.

Air traffic controllers currently broadcast Automatic Terminal Information Service (ATIS) messages verbally. The present system sometimes suffers from poor intelligibility of the broadcase due to inconsistent recording quality, differences in voice characteristics, and noise on the radio channel. One proposed enhancement is the use of digitized/ synthesized speech to replace the recorded human voice to gain consistency in the broadcast message.

Moreover, a need exists to retain both digital and voice messages for the mixed environment of aircraft that are Data Link equipped and for aircraft that do not have digital capability. However, providing both types of messages effectively doubles the time required for air traffic controllers to prepare the messages. A potential solution is to use voice synthesis to "read" the digital messages and transmit them in synthetic voice.

Speech synthesis of ATIS messages has not been fully tested in an operational environment. The Federal Aviation Administration (FAA) Technical Center, Atlantic City International Airport, New Jersey, under contract DTFA03-94-Q-00022, tasked ARINC and CTA Incorporated to evaluate the effectiveness of synthetic voice ATIS messages in a simulated environment. The evaluation, consisted of a flight demonstration in the General Aviation Trainer (GAT), flight simulator at the FAA Technical Center. The GAT is a motion-based general aviation trainer representing a Cessna 421 aircraft and has out-of-the-window visual renditions of the Atlantic City International Airport airport and environs.

The demonstration was held from November 28 through December 2, 1994. Pilots flew two scenarios and heard two ATIS messages during each scenario—one using human voice and one using synthetic voice.

The demonstration had the following objectives:

a. Evaluate the synthetic voice messages using measures of speed, clarity and intelligibility, and overall quality.

b. Compare the pilots' responses to the synthetic voice messages with their responses to the human voice messages.

These objectives were achieved by evaluating subjective and objective measures collected from the pilots and cockpit observers during the flight demonstration.

1.2 ORGANIZATION OF REPORT.

Section 2 describes the methodology used for the evaluation. Section 3 describes the results, and section 4 presents conclusions and recommendations.

2. METHODOLOGY.

Ten pilots from the Atlantic City area were selected for the demonstration. All 10 had some previous experience with ATIS. For the purposes of this study, pilots with more than 300 hours of multiengine experience were considered expert, while those with less than 300 hours were considered novices. Of the initial 10 pilots selected, 5 were novices and 5 were experts. However, two of the expert pilots could not complete the demonstration because of conflicting schedules and both of the available replacement pilots were novice pilots. Therefore, the demonstration was conducted with seven novice pilots and three expert pilots.

Two flight scenarios were designed to provide the pilots with different flight experiences to reduce the amount of learning resulting from repetition. Each scenario was developed based on an approach to Atlantic City International Airport, lasted about 40 minutes, and included some turbulence and background noise for realism. The scenarios presented the following routes:

a. Scenario 1: CANNY-MIV-SIE-ACY via VHF omnirange (VOR), runway 31

b. Scenario 2: CANNY-DONIL-VCN-ACY via instrument landing system (ILS), runway 13

Appendix A illustrates both flight routes.

Four different ATIS messages were developed for the demonstration, and each was recorded twice—once using human voice and once using synthetic voice. All of the messages, which were developed with the help of a certified terminal controller, contained information about conditions such as weather, wind, altimeter, runway, and taxiways. In addition, the test messages used excerpts from actual ATIS broadcasts from the airport. The controller's voice was used for the human voice message, and a Digital Equipment Corporation DECtalk System was used to generate the synthetic voice message. Although DECtalk allows for customization of words and phrases, that option was not employed. The basic text to speech synthesis inherent in the system was used. Both the human and synthetic voice messages were recorded on a Silicon Graphics workstation and played over the simulator audio system during each flight. Appendix B presents the contents of the four ATIS messages.

Two sessions were conducted each day. During the first hour of a session, the pilot subject received training in the use of the simulator and background information about the simulation.

Following a break, one of the flight scenarios was run for data collection. Two of the four messages were played during the scenario-one in synthetic voice and one in human voice. After another break, the second flight scenario was run, during which the remaining two messages were played—one in synthetic voice and one in human voice. The order of both the messages and type of voice used were varied throughout the data collection. For half of the simulations, a human voice message was presented first, followed by a synthetic voice message; the other half of the simulations followed the reverse order. Each pilot flew both scenarios. Half of the pilots experienced scenario 1 first, and half experienced scenario 2 first. Appendix C lists the order of

presentation for each pilot, and appendix D presents the daily schedule. The pilots flew under visual flight rules (VFR) conditions and could use autopilot at their discretion. Pilots were requested to check their ATIS messages twice during the simulation—once just after starting the flight and again just before contacting the tower during approach.

A cockpit observer, who was also a pilot, sat in the copilot's seat during each session. After an ATIS message was received, the observer recorded the number of times the pilot listened to each message and recorded whether the pilot took any of the following actions after hearing a message:

a. Changed the altimeter setting.

b. Altered the approach based on the change-of-runway information.

c. Correctly recorded, on the pilot's knee pad, information that was changed from the previous message.

d. Correctly repeated the altimeter setting or runway change when questioned by the observer.

These observations and pilot's comments were recorded on a questionnaire presented in appendix E. The observer was also encouraged to record his or her own opinions and comments about the quality of the synthetic voice messages.

To create realistic background traffic and communications, an air traffic controller provided air traffic control (ATC) instructions to the pilot subjects and provided cross talk with three additional pseudo pilots who acted as other aircraft to provide simulated traffic.

Following each session, the pilot completed a questionnaire, rating the speed, clarity and intelligibility, and overall quality of the synthetic voice message. The questionnaire also asked whether the pilot preferred natural or synthetic voice and solicited any additional comments the pilot wished to make. Appendix F presents a copy of the questionnaire, and appendix G lists the pilots' ratings and comments.

3. RESULTS.

Table 1 summarizes the questionnaire responses of the seven novice and three experienced pilots who participated in this demonstration. The results are discussed in the following subsections.

3.1 HOURS OF EXPERIENCE.

The mean hours of experience was 43 for the seven novice pilots and 1,433 for the three experienced pilots. One of the novice pilots reported having only single-engine experience.

3.2 SPEED.

Pilots were asked to rate, on a 7-point scale, the speed of the synthetic voice, where 1 was too fast, 4 was adequate, and 7 was too slow. The overall mean was 4.3 (standard deviation of 0.66)—only slightly slower than adequate. This indicates that no significant changes are required to the speed of the synthetic voice. Three pilots (all novices) commented that the message was too slow and rated the speed as 6, 5, and 5, respectively. All of the other pilots rated the speed of the synthetic voice as 4.

3.3 CLARITY AND INTELLIGIBILITY.

Pilots were asked to rate, on a 7-point scale, the clarity and intelligibility of the synthetic voice, where 1 was not clear, 4 was somewhat clear, and 7 was completely clear. The overall mean was 5.6 (standard deviation of 1.36). None of the pilots rated clarity and intelligibility as less than 4, and four of the pilots rated it as 7. For the six pilots who rated clarity and intelligibility as less than 7, some improvement was desired. Some commented that they had difficulty with certain words and others indicated that they thought the voice had a foreign accent.

TABLE 1. PILOT RATINGS OF SYNTHETIC VOICE ATIS MESSAGES

Pilot	Hours of Experience	Speed	Clarity	Quality	Preference
Novice Pilots					
1	92	6.00	4.00	2.00	Natural
2	75	4.00	7.00	6.00	Natural
3	30	4.00	4.00	4.00	Natural
4	32	4.00	7.00	7.00	No preference
5	40	5.00	7.00	5.00	Natural
7	0	5.00	6.00	7.00	No preference
10	30	4.00	7.00	7.00	Synthetic
Mean	43	4.57	6.00	5.43	
Experienced Pilots					
6	500	4.00	4.00	4.00	Natural*
8	1,300	4.00	6.00	6.00	Synthetic
9	2,500	4.00	4.00	4.00	Natural
Mean	1,433	4.00	4.67	4.67	
Total Mean		4.30	5.60	5.20	
Standard Deviation		0.66	1.36	1.16	

* This was the only pilot who missed the change of altimeter settings.

It might be expected that more experienced pilots, who have heard more ATIS messages given by a greater diversity of controllers, would be able to understand the synthetic voice more readily than less experienced pilots. Such was not the case. The mean rating from novice pilots was 6.0 and from experienced pilots was 4.67. Examination of the comments did not explain this disparity.

3.4 OVERALL QUALITY.

Pilots were asked to rate, on a 7-point scale, the overall quality of the synthetic voice, where 1 was not at all acceptable and 7 was completely acceptable. The responses varied greatly. Three pilots rated the overall quality as 7, two rated it as 6, one rated it as 5, three rated it as 4, and one rated it as 2. The overall mean was 5.2 (standard deviation of 1.16). These ratings indicate that although the overall quality of the synthetic voice was acceptable, there is a need for improvement. The comments from the pilots indicated the following problems:

a. Synthetic voice is difficult to interpret in high-workload situations.

b. Uninitiated pilots need time to become accustomed to the system.

c. Clarity needs to be improved.

d. Speed should be increased.

e. The foreign-sounding accent hinders understandability.

f. More attention and concentration are required than for human voice.

Novice pilots rated the acceptability of the quality slightly higher (mean of 5.43) than did experienced pilots (mean of 4.67).

3.5 PREFERENCE.

The pilots were asked which type of ATIS message they preferred—natural voice, synthetic voice, or no preference. Six of the pilots indicated a preference for natural voice, two preferred synthetic voice, and two have no preference. Although all of the pilots rated clarity and intelligibility as at least somewhat clear, and all but one pilot considered overall quality to be at least moderately acceptable, over half preferred natural voice.

It is important to note that although the pilots had little or no previous experience with synthetic voice, 4 of the 10 either had no preference or preferred the synthetic voice. The question can be raised as to what impact experience with synthetic voice has on preference and acceptability.

Flight experience did not present a correlation with preference. Of the novice pilots, four preferred natural voice, one preferred synthetic voice, and two had no preference. Of the three experienced pilots, two preferred natural voice, and one preferred synthetic voice.

3.6 BACKGROUND TRAFFIC.

After the first trial, an additional item was handwritten into the questionnaire. Pilots were asked to rate the background traffic provided by the simulation environment. Of the nine pilots who responded, six rated traffic as normal, and three rated it as normal to light. Some of the pilots commented that background traffic was normal for Atlantic City but light for other areas. None of the pilots rated the traffic as heavy.

3.7 OBJECTIVE MEASURES.

All of the pilots correctly altered their approach based on change-of-runway information given in the ATIS messages. This reaction occurred regardless of whether the pilot heard the human voice or synthetic voice message.

Only one of the pilots (pilot #6) missed the change of altimeter reading. This occurred for both synthetic voice messages. The observer noted that this pilot had difficulty handling the workload and missed the change of altimeter reading for the human voice message as well. It is interesting to note that although this pilot missed instructions, he rated the background traffic as normal to light and rated the synthetic voice as 4 for speed, 4 for clarity and intelligibility, and 4 for overall quality.

Table 2 presents the results from the Observer Questionnaires and shows for each pilot, the order of the scenarios, the mode of presentation of each of the messages and the number of times the pilot listened to each message (repetitions). Table 3 shows the mean number of times that the pilots listened to a message. The mean number of times pilot subjects listened to ATIS was 1.27 for both natural and synthetic speech cases. One pilot listened to two human voice messages three times.

The Charlie and Echo messages were always given early in a scenario and represented times of relatively low workload. The Delta and Foxtrot messages were given later in a scenario and represented times of higher workload. If higher workload increased the number of times the synthetic messages were listened to, the Delta and Foxtrot messages should have required more repetitions. However, the synthetic voice Delta message was listened to an average of 1.5 times (compared with 1.25 times for human voice), and the synthetic voice Foxtrot message was listened to an average of 1.0 times (compared with 1.5 times for human voice). Therefore, no connection was demonstrated between workload and the number of times that a pilot listened to the synthetic voice messages.

TABLE 2. NUMBER OF REPETITIONS OF ATIS MESSAGES BY SCENARIO, SOURCE, MESSAGE AND PILOT NUMBER

Pilot Number	Scenario	Source/Message	Repetitions
1	1	Human/Charlie	3
		DECtalk/Delta	2
	2	DECtalk/Echo	2
		Human/Foxtrot	3
2	2	Human/Echo	1
		DECtalk/Foxtrot	1
	1	DECtalk/Charlie	2
		Human/Delta	2
3	2	DECtalk/Echo	2
		Human/Foxtrot	2
	1	Human/Charlie	1
		DECtalk/Delta	2
4	1	Human/Charlie	1
		DECtalk/Delta	1
	2	DECtalk/Echo	1
		Human/Foxtrot	1
5	1	Human/Charlie	1
		DECtalk/Delta	1
	2	DECtalk/Echo	1
		Human/Foxtrot	1
6	1	Human/Charlie	1
		DECtalk/Delta	1
	2	DECtalk/Echo	1
		Human/Foxtrot	1
7	2	DECtalk/Echo	1
		Human/Foxtrot	1
	1	Human/Charlie	1
		DECtalk/Delta	2
8	2	Human/Echo	1
		DECtalk/Foxtrot	1
	1	DECtalk/Charlie	1
		Human/Delta	1
9	1	DECtalk/Charlie	1
		Human/Delta	1
	2	Human/Echo	1
		DECtalk/Foxtrot	1
10	2	Human/Echo	1
		DECtalk/Foxtrot	1
	1	DECtalk/Charlie	1
		Human/Delta	1

Table 3 shows the mean number of repetitions for each message and source.

TABLE 3. MEAN REPETITIONS OF ATIS MESSAGES BY SOURCE AND MESSAGE

Source	Message	No. Pilots	Mean Repetitions
Human	Charlie	6	1.33
Human	Delta	4	1.25
Human	Echo	4	1.0
Human	Foxtrot	6	1.50
Mean - Human			1.27
DECtalk	Charlie	4	1.25
DECtalk	Delta	6	1.50
DECtalk	Echo	6	1.33
DECtalk	Foxtrot	4	1.00
Mean - DECtalk			1.27

4. DATA ANALYSIS.

The objective data shows that the pilot subjects received sufficient information from natural or synthetic ATIS to execute an approach and landing at Atlantic City. The subject's ability to acquire change of runway and altimeter information from ATIS was consistent. It is noted that these two pieces of information are short and familiar to pilots. In the subjective data for the synthetic case, pilots and observers commented that (1) longer multisyllablic words, and (2) NOTAMS may be more difficult to interpret from synthetic speech. Combining these subjective and objective results, it becomes evident that shorter length message segments that contain familiar, or at least expected information were more readily understood by the pilot subjects than the longer more complex segments. Longer, more complex messages required more concentration by the pilot subjects, to acquire all of the information contained.

Workload was reported as a concern by several of the pilot subjects in the test scenarios, where workload associated with the flying task was designed to be medium. It must be assumed therefore, that synthetic ATIS, in the configuration used for this demonstration, may be unacceptable in flights where the workload is high.

5. CONCLUSIONS AND RECOMMENDATIONS.

Both experienced and novice pilots favorably rated intelligibility and overall quality. Although some pilots indicated a belief that the synthetic voice messages added to their workload, they did not need to listen to additional iterations of the messages. Furthermore, only one pilot missed important information from the synthetic message and that same pilot missed important information given by the human controller as well.

Perhaps the most significant result of this study is a set of ratings of a typical medium quality speech synthesis system. This study demonstration was conducted with sufficient rigor to provide repeatable measures in future evaluations. Two possible means exist for improvements ot the speech synthesis process: (a) acquire a more sophisticated system, and (b) customize the more difficult words within the DECtalk vocabulary to provide more natural speech overall.

The first alternative is technology (and expense) driven, although there is a very promising system available, called Eloquent Technology, which has been introduced in the last several months. The second alternative uses existing technology and is feasible. The customization of the vocabulary would be equivalent to a site adaptation exercise, and would be performed within the region.

Follow-on studies in the GAT are suggested because performance gains over the current synthesis system can be assessed using similiar scenarios and data collection methods. Furthermore, if an additional study is performed using customized DECtalk, the amount of effort spent improving the vocabulary will be documented as a case study of site adaptation. From this data, the cost of adaptations at other airports may be predicted.

Lastly, if improvements to the base technology are realized, these systems may also be comparatively evaluated in a GAT study.

It is therefore recommended that the Technical Center plan and conduct at least one additional study, with natural voice as baseline, and customized DECtalk and the Eloquent system as test cases.

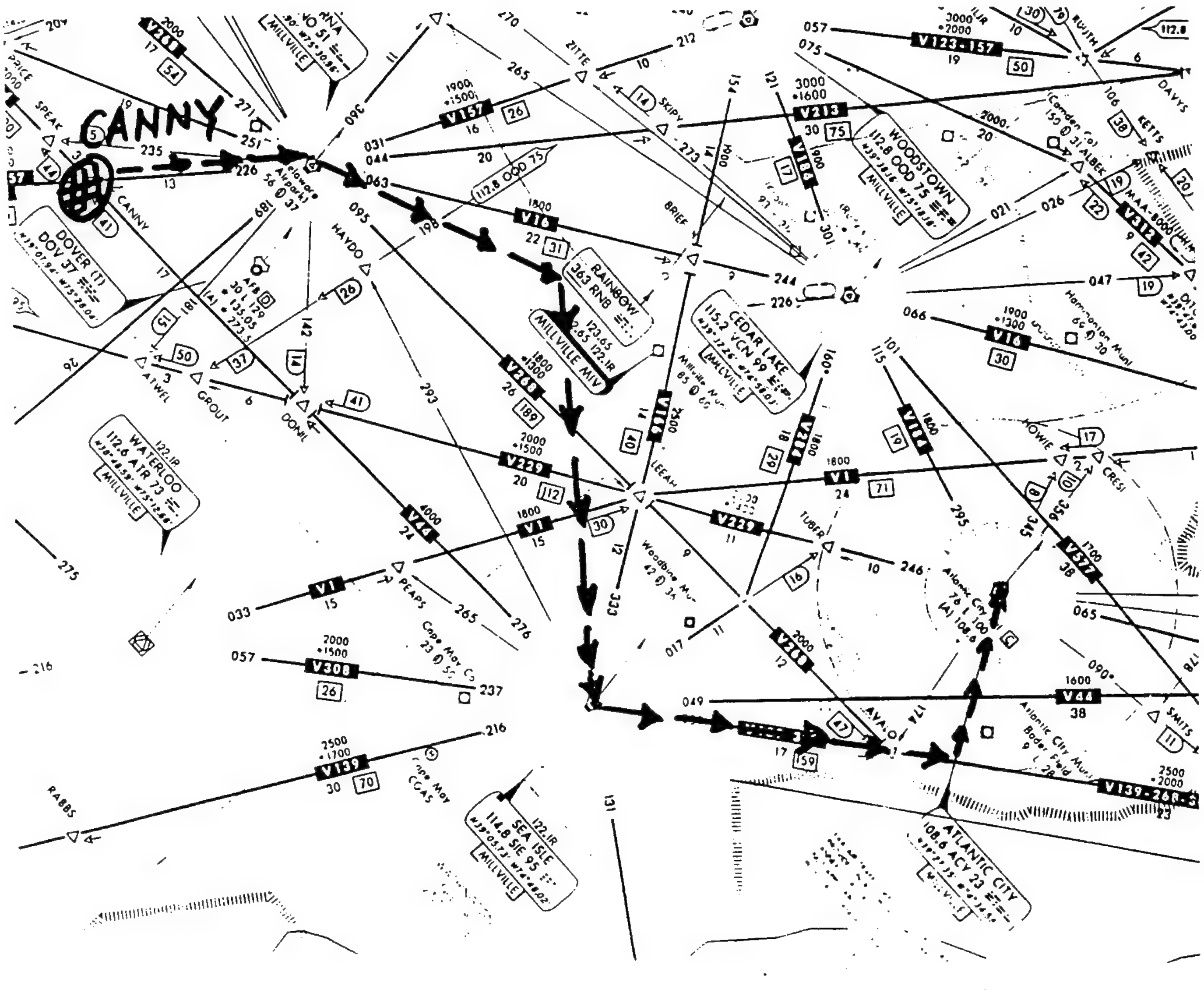
6. ABBREVIATIONS AND ACRONYMS.

ATIS	Automatic Terminal Information Service
ATC	Air Traffic Control
FAA	Federal Aviation Administration
GAT	General Aviation Trainer
ILS	Instrument Landing System
NOTAM	Notice to Airmen
VFR	Visual Flight Rules
VOR	VHF Omnirange

APPENDIX A

FLIGHT ROUTES

Scenario 1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SEA ISLE
114.8 SIE 95
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V308
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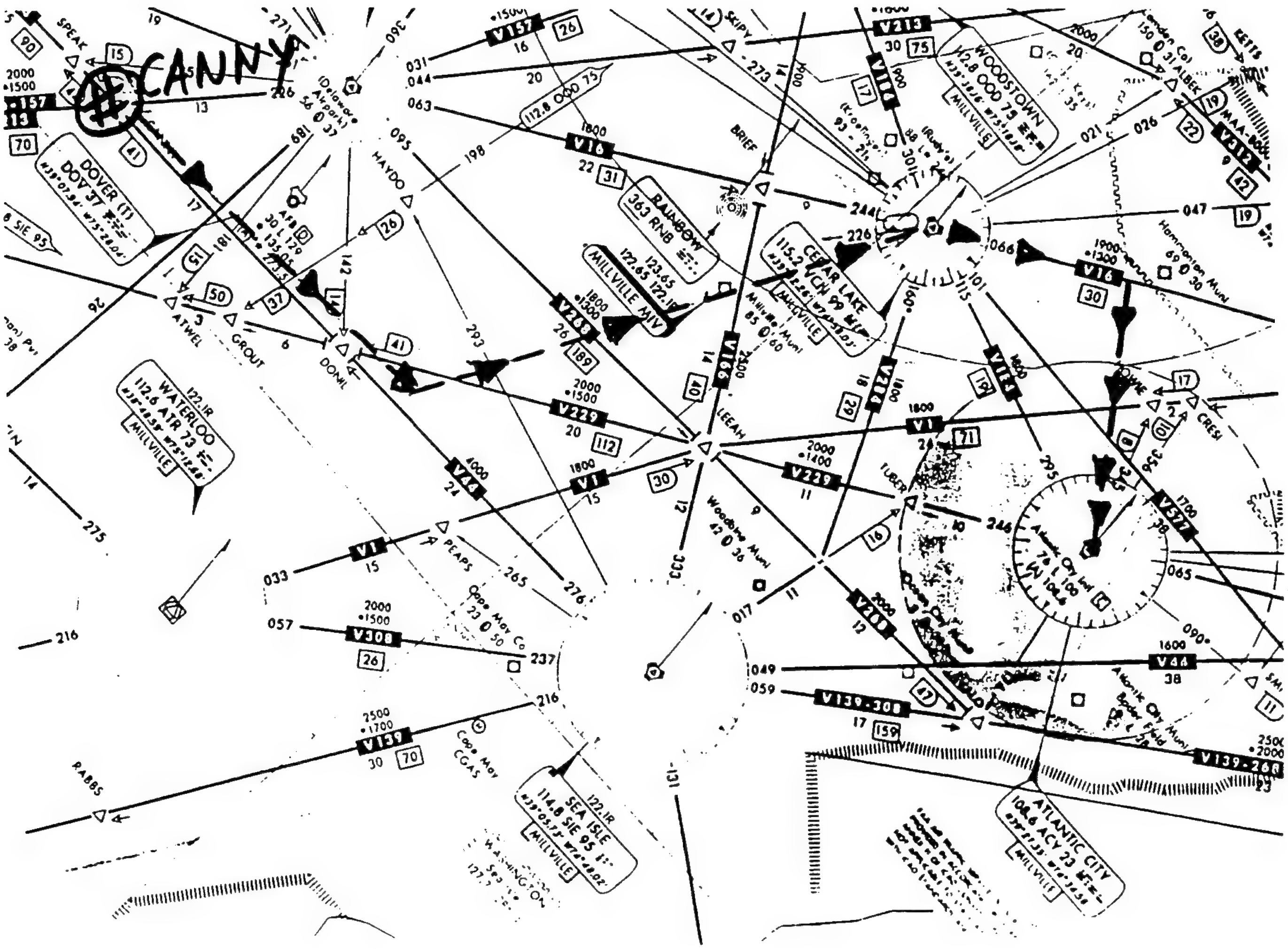
V213
V268

Scenario 2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DOVER
DOV 37
WATERLOO
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WOODSTOWN
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CEDAR LAKE
115.2 VCN 99
RAINBOW
363 RNB
MILLVILLE MIV
SEA ISLE
114.8 SIE 95
ATLANTIC CITY
108.6 ACY 23
V1
V16
V229
V308
V139
V44

APPENDIX B

ATIS MESSAGES

Scenario 1

Message # 1 (Charlie)

Atlantic City International Airport Information Charlie. One four zero zero Zulu. Measured ceiling four thousand, five hundred broken. Visibility one-and-one-half fog. Temperature four niner. Dew point four seven. Wind one five zero at five. Altimeter three zero zero zero. ILS runway one three approach in use. Notices to airmen: The last one thousand, two hundred feet of runway one three closed. Eight thousand, eight hundred feet usable. Taxiway Bravo between taxiways Juliet and Kilo closed. Runway three one VASIs out of service. Advise on initial contact you have information Charlie.

Message # 2 (Delta)

Atlantic City International Airport Information Delta. One four two zero Zulu. Measured ceiling four thousand, five hundred broken. Visibility one-and-one-half fog. Temperature five zero. Dew point four eight. Wind two seven zero at five. Altimeter two niner niner two. VOR runway three one approach in use. Notices to airmen: Runway three one threshold displaced one thousand, two hundred feet. Eight thousand, eight hundred feet usable. Relocated threshold identified by five-foot solid white line and runway end identifier lights. Taxiway Bravo between taxiways Juliet and Kilo closed. Runway three one VASIs out of service. Advise on initial contact you have information Delta.

Scenario 2

Message # 1 (Echo)

Atlantic City International Airport Information Echo. One five zero zero Zulu. Sky partially obscured. Visibility one-and-one-half fog. Temperature four five. Dew point four three. Wind calm. Altimeter two niner niner two. VOR runway three one approach in use. Notices to airmen: Runway three one threshold displaced one thousand, two hundred feet. Eight thousand, eight hundred feet usable. Relocated threshold identified by five foot solid white line and runway end identifier lights. Taxiway Bravo between Taxiways Juliet and Kilo closed. Runway three one VASIs out of service. Advise on initial contact you have information Echo.

Message # 2 (Foxtrot)

Atlantic City International Airport Information Foxtrot. One five one five Zulu. Sky partially obscured. Visibility one-half fog. Temperature four five. Dew point four four. Wind one five zero at five. Altimeter three zero zero zero. ILS runway one three approach in use. Notices to airmen: The last one thousand, two hundred feet of runway one three closed. Eight thousand, eight hundred feet usable. Taxiways Bravo between Taxiways Juliet and Kilo closed. Runway three one VASIs out of service. Advise on initial contact you have information Foxtrot.

APPENDIX C

ORDER OF PRESENTATION

Day 1: Date: November 28, 1994 (Monday)

Morning session Pilot 1:	Scenario 1 (Human Charlie, Synthetic Delta) Scenario 2 (Synthetic Echo, Human Foxtrot)
Afternoon session Pilot 2:	Scenario 2 (Human Echo, Synthetic Foxtrot) Scenario 1 (Synthetic Charlie, Human Delta)

Day 2: Date: November 29, 1994 (Tuesday)

Morning session Pilot 3:	Scenario 2 (Synthetic Echo, Human Foxtrot) Scenario 1 (Human Charlie, Synthetic Delta)
Afternoon session Pilot 4:	Scenario 1 (Human Charlie, Synthetic Delta) Scenario 2 (Synthetic Echo, Human Foxtrot)

Day 3: Date: November 30, 1994 (Wednesday)

Morning session Pilot 5:	Scenario 1 (Human Charlie, Synthetic Delta) Scenario 2 (Synthetic Echo, Human Foxtrot)
Afternoon session Pilot 6:	Scenario 1 (Human Charlie, Synthetic Delta) Scenario 2 (Synthetic Echo, Human Foxtrot)

Day 4: Date: December 1, 1994 (Thursday)

Morning session Pilot 7:	Scenario 2 (Synthetic Echo, Human Foxtrot) Scenario 1 (Human Charlie, Synthetic Delta)
Afternoon session Pilot 8:	Scenario 2 (Human Echo, Synthetic Foxtrot) Scenario 1 (Synthetic Charlie, Human Delta)

Day 5: Date: December 2, 1994 (Friday)

Morning session Pilot 9:	Scenario 1 (Synthetic Charlie, Human Delta) Scenario 2 (Human Echo, Synthetic Foxtrot)
Afternoon session Pilot 10:	Scenario 2 (Human Echo, Synthetic Foxtrot) Scenario 1 (Synthetic Charlie, Human Delta)

APPENDIX D

SCHEDULE

Shakedown Date: November 14, 1994 (Monday)

Test Dates: November 28 to December 2, 1994

Time: 8 a.m. to 4 p.m.

There were two sessions every day. Each session will have two flights. Each flight took approximately 40 minutes.

Training Period:	8 a.m. to 9 a.m.
Morning Session:	9 a.m. to 11 a.m.
Lunch:	11 a.m. to 12 p.m.
Training Period:	12 p.m. to 1 p.m.
Afternoon Session:	1 p.m. to 3 p.m.
Demonstration/Debrief:	3 p.m. to 4 p.m.

APPENDIX E

OBSERVER QUESTIONNAIRE

OBSERVER QUESTIONNAIRE

SIMULATION: SYNTHETIC VOICE FOR ATIS MESSAGES

Name:
Hours of multi-engine experience:
Date: **Session: Morning / Afternoon (circle one)**

As an observer, you will ask the pilot the altimeter reading and runway after the ATIS message is complete. There will be two ATIS messages in each scenario. The two will differ in their message content and their source. Each pilot will complete two scenarios.

SCENARIO 1

ATIS Message: *Charlie*

Nature of message: Human / Synthetic (circle one)

1. What is the pilot's response to your question "what was the altimeter reading"?

_____

2. What is the pilot's response to your question "what runway is in use now"?

_____

3. How many times did the pilot listen to the message?

_____

ATIS Message: *Delta*

Nature of message: Human / Synthetic (circle one)

1. What is the pilot's response to your question "what was the altimeter reading"?

_____

2. What is the pilot's response to your question "what runway is in use now"?

_____

3. How many times did the pilot listen to the message?

_____

SCENARIO 2

ATIS Message: *Echo*

Nature of message: Human / Synthetic (circle one)

1. What is the pilot's response to your question "what was the altimeter reading"?

_____

2. What is the pilot's response to your question "what runway is in use now"?

_____

3. How many times did the pilot listen to the message?

_____

ATIS Message: *Foxtrot*

Nature of message: Human / Synthetic (circle one)

1. What is the pilot's response to your question "what was the altimeter reading"?

_____

2. What is the pilot's response to your question "what runway is in use now"?

_____

3. How many times did the pilot listen to the message?

_____

General Questions

1. What is your overall opinion about the synthetic ATIS message?

Acceptable / Unacceptable (circle one)

2. Do you have any additional comments or opinions about the synthetic ATIS messages (use back side if necessary)?

_____

_____

_____

_____

Please return to Parimal Kopardekar. Thank you for your participation in the study.

APPENDIX F

PILOT QUESTIONNAIRE

PILOT QUESTIONNAIRE

SIMULATION: SYNTHETIC VOICE FOR ATIS MESSAGES

Name:

Hours of multi-engine experience: **Date:**

Quality of synthetic voice

1. How did the speed of the synthetic voice sound to you?

1	2	3	4	5	6	7
Too Fast			Adequate			Too Slow

Please justify your response if it is any other than 4 (use back side if necessary).

_____

_____

2. Do you think the synthetic ATIS message was clear and intelligible?

1	2	3	4	5	6	7
Not Clear			Somewhat Clear			Completely Clear

Please justify your response if it is any other than 7 (use back side if necessary).

_____

_____

3. Which type of ATIS message do you prefer? (circle one)

Natural Voice Synthetic Voice No Preference

4. Do you think the overall quality of ATIS message, recorded in synthetic voice, is acceptable?

1	2	3	4	5	6	7
Not At All						Completely

Please justify your response if it is any other than 7 (use back side if necessary).

_____

_____

5. Please feel to mention any other comments, opinions, or concerns you may have about synthetic ATIS message (use back side).

_____

Please return to Parimal Kopardekar. Thank you for your participation in the survey.

APPENDIX G

COMMENTS FROM PILOT AND OBSERVER QUESTIONNAIRES

PILOT RATINGS AND COMMENTS

NOTE: On questions where pilots were asked to provide both a rating and comments, the rating is shown before the comments. Refer to Appendix F for a description of the rating scales used for each question.

1. *How did the speed of the synthetic voice sound to you?*

Pilot 1: 6 — Information dragged out too much, distracted me from flying.

Pilot 2: 4 — No comment.

Pilot 3: 4 — No comment.

Pilot 4: 4 — No comment.

Pilot 5: 5 — Voice too slow.

Pilot 6: 4 — No comment.

Pilot 7: 5 — Seemed a little slower than a normal ATIS, but not really objectionable.

Pilot 8: 4 — No comment.

Pilot 9: 4 — No comment.

Pilot 10: 4 — No comment.

2. *Do you think the synthetic ATIS message was clear and intelligible?*

Pilot 1: 4 — Certain words yes, others were not.

Pilot 2: 7 — No comment.

Pilot 3: 4 — Not as clear as the GAI AWOS I am used to listening to when I fly there. It is also not a real human voice.

Pilot 4: 7 — No problem understanding the verbiage.

Pilot 5: 7 — No comment.

Pilot 6: 4 — Because the voice was of foreign origin, more concentration is required to understand words.

Pilot 7: 6 — Had trouble once understanding the number "five'; also seemed to have a slight foreign accent (maybe Scandinavian).

Pilot 8: 6 — The receiver/speaker was little touchy, but the voice message was fine.

Pilot 9: 4 — Some words difficult to understand—hard consonance in particular. Had to listen twice to ATIS to get some words.

Pilot 10: 7 — No comment.

3. *Which type of ATIS message do you prefer?*

Pilot 1: Natural voice.

Pilot 2: Natural voice.

Pilot 3: Natural voice,

Pilot 4: No preference.

Pilot 5: Natural voice.

Pilot 6: Natural voice.

Pilot 7: No preference.

Pilot 8: Synthetic voice.

Pilot 9: Natural voice.

Pilot 10: Synthetic voice.

4. *Do you think the overall quality of ATIS message, recorded in synthetic voice, is acceptable?*

Pilot 1: 2 — I am currently only familiar with natural voice. In high-workload situations, synthetic voice was too difficult to interpret.

Pilot 2: 6 — It will require some time to get used to for the uninitiated.

Pilot 3: 4 — Could be clearer. I really don't have any preference of human voice versus synthetic, as long as it is clear.

Pilot 4: 7 — No comment.

Pilot 5: 5 — Voice was too slow.

Pilot 6: 4 — Because the voice was of foreign origin, more concentration is required to understand words.

Pilot 7: 7 — Could be slightly better (a little faster), but [is] at least as good as the average of all natural voice ATIS I've heard.

Pilot 8: 6 — Very good voice and pattern. I had a little problem, but it was only unfamiliarity with the trainer.

Pilot 9: 4 — Somewhat difficult to understand at times; required more attention and concentration compared to natural voice. On second ATC scenario did not attempt to listen to ATIS until aircraft was in benign phase of flight (i.e., stable heading and altitude).

Pilot 10: 7 — No comment.

5. *Please feel free to mention any other comments, opinions, or concerns you may have about synthetic ATIS message.*

Pilot 1: It was too hard to interpret synthetic voice ATIS in a high-workload situation. It distracted me from flying because I had to concentrate on what was being said. In a lower work situation during the test I understood it better.

Pilot 2: No comment.

Pilot 3: No comment.

Pilot 4: For my level of experience (low multiengine time), I was quite busy. As long as the synthetic ATIS is clear with the same order of information that the pilot is used to, it is adequate.

Pilot 5: No comment.

Pilot 6: No comment.

Pilot 7: I suggest you get some subject pilots who are not native English speakers; they would be more sensitive to this than I am. The NOTAMs in this ATIS were exactly what we're used to now here at ACY. It might be better to put in some nonstandard NOTAMs.

Pilot 8: I feel it is better than human because of the consistency.

Pilot 9: Synthetic voice ATIS needs improvement in voice quality before implementation. Need to approach quality of natural voice to minimize concentration required to comprehend all data.

Pilot 10: No comment.

6. *How do you find the background traffic?*

Pilot 1: No response.

Pilot 2: Normal.

Pilot 3: Normal.

Pilot 4: Light side of normal.

Pilot 5: Normal.

Pilot 6: Normal to light.

Pilot 7: Normal (normal for ACY but light compared with a lot of other environments).

Pilot 8: Normal.

Pilot 9: Normal.

Pilot 10: Normal.

OBSERVER COMMENTS

The following comments were made by the pilots to the observer during the flight and were recorded by the observer in response to general question 2 on the observer questionnaire (refer to Appendix E).

Do you have any additional comments or opinions about the synthetic ATIS messages?

Pilot 1: Multisyllabic words are hard to understand—pause too great (i.e., visibility 1 mile or 1 and 1/2)? Pilot flies for a living.

Pilot 2: Length of ATIS NOTAMs has some bearing on number of times a pilot will listen to the ATIS.

Brief pilots on glide slope flag in view on ILS.

NOTAM messages are more difficult to understand. Subjects may get altimeter and runway but not understand NOTAMs with synthetic.

As far as comparing synthetic to human, I've heard much better human ATIS and a few that were worse. Perhaps consider saving human voice words on tapes and use them.

Pilot 3: Pilot workload was high, not experienced with this type flight deck. ATIS [(syn)synthetic] was just acceptable, required more attention.

Pilot 4: Pilot did not use autopilot.

Pilot 5: Pilot went back approximately 7-10 min after start of scenario 2 and listened to ATIS echo (only about half).

Pilot 6: The pilot during this problem appeared to be "behind the power curve" complying with ATC instructions. When the ATIS messages changed from Charlie to Delta, the pilot immediately went to receive the new information and did not hear (or comply with) instructions which would allow the aircraft to proceed as scripted.

Pilot 7: Pilot used autopilot during high-workload times.

Pilot 8: Used autopilot.

Pilot 9: Pilot used autopilot all the time. Pilot flies for a living.

Pilot 10: No comment.

APPENDIX H

PERSONNEL

Test Director—Albert Rehmann

Scenario Development and ATC Support—Frank Ferrera

ATIS Messages Preparation—John Goon and Parimal Kopardekar (CTA Incorporated)

ATC Support—Evan Darby

General Aviation Simulation Facility Engineering Support—Joe McCall and George Bollenbach

Expert Pilot and Pilot Scheduling—Theos McKinney

Software Support—Joe McCall, George Bollenbach, and Pocholo Bravo

Test Plan and Study Preparation—Parimal Kopardekar (CTA Incorporated), Richard Mogford (CTA Incorporated), and Margaret T. Shaffer (ARINC)

Data Collection and General Support—Parimal Kopardekar (CTA Incorporated), Margaet T. Shaffer (ARINC)

Data Analysis and Report Preparation—Margaret T. Shaffer (ARINC)